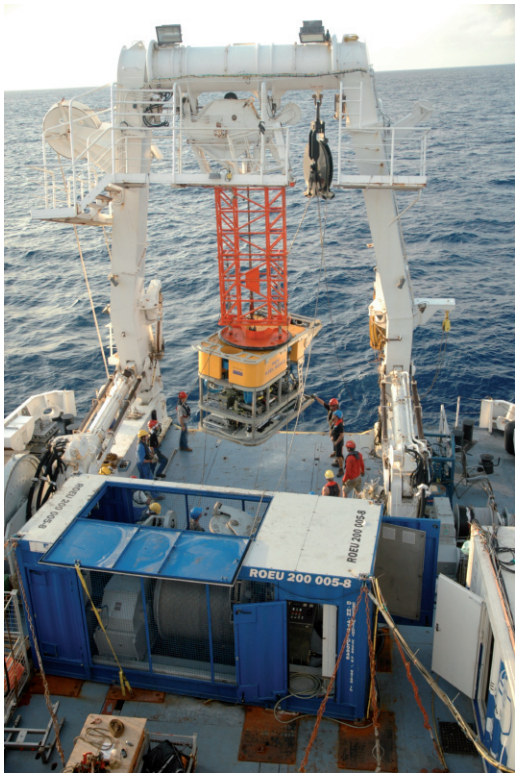
ROV Kiel6000: Hands and eyes at the bottom of the ocean

The year 2007 saw IFM-GEOMAR take delivery of its first Remotely Operated Vehicle ("ROV"), fully financed by the State of Schleswig –Holstein to the tune of 4,7 Million Euro. For that price tag you get 5 containers containing about 50 tonnes of equipment which is all you need to send television cameras, remotely-controlled arms and a host of user-built sampling devices and experiments to the bottom of the ocean, down to 6 km depth. The vehicle which makes the dive is connected to the surface ship via a cable which transmits up to 60 kilowatts of power and transports, in three glass fibres, information between the vehicle and the control van on the ship. The vehicle is equipped with both high-definition (HDTV) and standard video cameras mounted on pan-and-tilt heads (and over 4 kilowatts of lighting) transmitting in real-time to the surface vessel. Onboard sensors include a forward-looking sonar, and depth, temperature and salinity units as well as bottom-tracking doppler sonar. And the front of the vehicle is equipped with two hydraulic manipulator arms for precision work on the seabed, capable of placing samples and equipment in the hydraulically-activated sampling bay. Seven electrical thrusters (with a combined pull of over 500 kilogram-

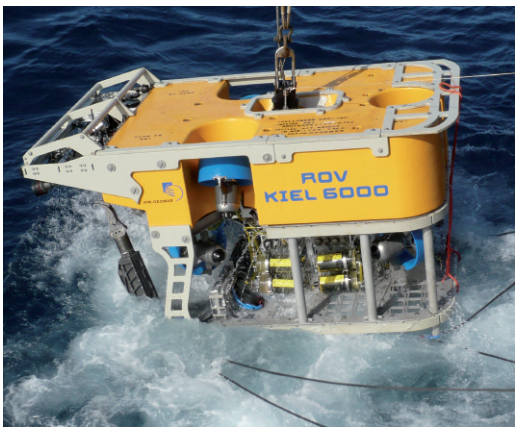


Control and navigation centre for the ROV Kiel 6000.

force) move the ROV at up to 1.5 knots through the water. All of this equipment is controlled via the standard TCP/IP protocol –the ROV is in effect a mobile network. Extra nodes on this network are available for hooking up additional scientific equipment – the standard internet protocol coupled with a flexible vehicle control software makes integrating this equipment into the vehicle a relatively simple task. A team of 8 people, including engineers for the mechanical, electrical, winch and computer systems and pilots to "fly" the vehicle and use the manipulator arms maintain, modify and deploy the vehicle when at sea. As this team stays on the ship and controls the ROV remotely, it is theoretically possible, by working in shifts, to dive indefinitely. Two pilots control the vehicle at any one time from the air-conditioned, darkened control van. They are accompanied by up to three scientists who determine the program to be followed and which samples or observations are to be taken. Via a dedicated network, crew and scientists all over the ship can however "participate" in the dive by watching the video images returned from the seafloor on video projection screens.

So why go to all this effort? Quite simply, the ROV provides unique opportunities for doing science in the deep sea. It carries enough lights and cameras to allow scientists to see exactly what is going on on the seafloor. Thanks to the high-performance software and the bottom-tracking doppler sonar, the pilots can steer and "park" the vehicle with centimeter accuracy, allowing them to position it ideally for the sceintific work. And the two remotely-controlled hydraulic arms mean that

Release of the ROV Kiel 6000 from the French research vessel l'Atalante.



Revovery of ROV Kiel 6000 after the first test dive.

experiments and measurements can be carried out on the seafloor almost as if they were being done in the home laboratory. So sampling, for example, specific individuals in a mussel bed is quite feasible, as is taking samples of the water bathing these mussels and measuring its temperature. Sampling specific parts of seafloor features such as mineralized "chimneys" is possible in unprecedented detail. And the masses of power available through the cable means that the vehicle can lift and move large equipment on the seafloor, a capability which will become increasingly useful in the future as the installation and servicing of seafloor observatories becomes a reality.

Young lava complex at the mid Atlantic ridge.

Delivered in August, the ROV saw its first sea trials in the same month off New Zealand onboard the German research vessel "Sonne" where it dived on hydrothermal vent fields in the Brothers volcano. Following this it was shipped directly to the first scientific cruises on board the French research vessel "Atalante" in December. During these cruises the ROV allowed scientists from such diverse fields as biology, mineralogy and water chemistry to study hydrothermal vents in the Atlantic. At the Logatchev field (15°N) the time-series sampling of vent fluids and their associated biological communities, financed as part of the DFG Priority Program SPP1144, was continued. At 5°S, whilst working at the Turtle Pits vent site, the ROV sampled the hottest vent fluids ever found in the oceans, measuring temperatures well above those thought feasible based on present theories of hydrothermal circulation. These fluids were emerging from a 1-cm-wide hole in the seafloor – unfeasible to sample without clear sight and precise movement of both vehicle and arms.

Mussel sampling near a hot vent in the Logatchev Field.

In the course of over 20 successful dives, the ROV has already proven its worth for the seafloor scientific community and in the process achieved a depth record for a German ROV of 4890m.

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